

determine the texture sections. Other embodiments may use different texture values, such as contrast levels, halftone levels, and edge frequencies. The exact type of texture value utilized is in fact intermediate, as long as the texture decision map **1820** suffices in identifying texture sections **1830** from the feature sections having texture values within a valid range according to the valid monetary banknote.

[0110] Generation of the texture decision map **1820** is now discussed in the following with reference to FIG. **19**. FIG. **19** illustrates an embodiment for generating the texture decision map **1820** according to the present invention. In a first step (**1910**), the image is divided into feature sections. This can be performed in a manner similar to FIG. **2** and FIG. **3** as shown for the verification sections, and therefore does not require further discussion. In certain embodiments, the feature sections may also correspond to the verification sections, or may also be configured in an overlapping manner.

[0111] Upon dividing the image into feature sections, a texture feature map having texture values for each feature section is generated in step **1920**. The texture feature map is generated from the original scanned image, and can comprise many types including: a gray level map having gray level values, a halftone map having halftone values, or a binary edge map having edge values. Additional embodiments may contain different types of texture feature maps, however, the above listed examples will be described later in further detail for use in conjunction with the present invention.

[0112] In step **1930**, border sections are included as texture sections. This step is included because border sections determined in banknote boundary generation **120** obviously correspond to the monetary banknote. Including the border sections as texture sections reduces some of the processing otherwise needed to determine this.

[0113] In step **1940**, feature sections having texture values within a first texture value threshold range are then selected as potential texture sections. This is a preliminary step to temporarily identify feature sections that have valid texture values when compared to a valid monetary bill. The first texture value threshold range therefore corresponds to a valid texture value range of a valid monetary bill.

[0114] In step **1950**, an average texture value for surrounding feature sections of each potential texture section is determined. This is because valid texture sections should have valid surrounding sections as well. An example of surrounding sections can also be drawn from FIG. **12**. Using this figure as an example, section **1212** can represent the potential texture section, while sections **1214** can represent the surrounding feature sections of **1212**. Alternate embodiments however, may illustrate different configurations, which still obey the teachings of the present invention. For example, the surrounding sections can be arranged in an overlapping, rotational, disjoint, offset, or shifted manner. In all such cases, the present invention method is equally applicable to maintain its desired functional goals. Therefore, the texture values for sections **1214** are calculated to determine an average texture value for the surrounding feature sections. The texture values, therefore, are calculated to determine an average texture value for the surrounding feature sections.

[0115] Finally, in step **1960**, potential texture sections that do have surrounding feature sections with the average texture value within a second texture value threshold range are included as texture sections. The second texture value

threshold range additionally corresponds to valid texture values of a valid monetary banknote. This step is a more global approach used to ensure uniformity in texture values around texture sections.

[0116] As discussed above, a gray level map can be used as the texture feature map, as it has gray level values for the texture values of each feature section. In this embodiment, the first texture value threshold range corresponds to a gray level of the valid monetary bill, while the second texture value threshold range also corresponds to a gray level of the valid monetary bill.

[0117] It is understood that monetary banknotes have a gray level variance within a specific predetermined range, and hence gray level characterization can be used as texture values. FIG. **20** is an example illustrating gray level variance charts for various objects. FIG. **20(a)** shows the range of gray level values for a US denomination banknote, while FIG. **20(b)** shows the gray levels corresponding to a piece of fabric, and FIG. **20(c)** illustrates the gray level values for black on white text. As the examples in FIG. **20** illustrates, every item tends to have a specific range of gray level variance. The fabric shown in FIG. **20(b)** tends to have less variance as it has a more uniform grayscale distribution. The black on white text in FIG. **20(c)** has a greater variance due to alternating dark text areas, and the white background. The monetary banknote in FIG. **20(a)** has the widest grayscale range among the three objects due to the different shades of gray inherent in the banknote. It is this characteristic that is exploited, as the first and second texture value threshold ranges are selected to correspond to the valid gray levels from a valid monetary bill.

[0118] Also as described, a halftone map can be used as a texture feature map, as halftone values of the halftone map can be the texture values for each feature section. In this embodiment, the first and second texture value threshold ranges correspond to halftone values of a valid monetary bill. Halftone maps distinguish halftone patterns or values, which can reveal feature sections having a predefined color range, and a predefined continuous color gradient range.

[0119] Put more specifically, halftone patterns can be defined as those with few or no neighbors in the same range of color hue (U,V) in YUV space, or (Cb,Cr) in YCbCr space. This is also known as halftone mode printing. FIG. **21** is an example illustrating an image using halftone mode printing (FIG. **21(b)**) and typical bill printing (FIG. **21(a)**). The bill printed image in FIG. **21(a)** shows a more continuous color gradient in a straight line, as any given pixel has surrounding pixels with the same or similar color tones. The halftone mode image in FIG. **21(b)** appears more disjoint, and has a greater variance in color and color continuity. Pixels in halftone images do not generally have surrounding pixels with similar color tones, and therefore do not have a continuous color gradient. In this step, feature sections that are printed in the halftone mode are omitted from further process steps, as they do not correspond to monetary banknotes. The feature sections having halftone values corresponding to a desired monetary banknote, and also having surrounding sections corresponding to a desired monetary banknote are then selected as texture sections in the texture decision map for further processing.

[0120] Finally, a binary edge map can represent the texture feature map, as it has edge values as the texture values for each feature section.